Specimen Question **Annexure-XXXVII**

DO NOT OPEN THE SEAL UNTIL YOU ARE TOLD TO DO SO

QP-FSL-2024 **Question Booklet No.**

Test Booklet Series

A

PHYSICS

PAPER—II

Time Allowed : 2 Hours **Maximum Marks : 200**

INSTRUCTIONS FOR CANDIDATES

1. Immediately after the commencement of the examination, you should check that this Test Booklet ***does not*** have any unprinted or torn or missing pages or questions etc. If so, get it replaced by a complete Test Booklet.
2. Write your Roll Number on the Test Booklet in the Box provided alongside.
3. This Test Booklet contains **200** questions. Each question comprises of four responses (answers) within as (A), (B), (C) and (D). You should select the response which you feel is the most ***correct*** and mark it on the OMR Answer Sheet.
4. You have to mark all your responses **ONLY** on the separate **OMR Answer Sheet** provided. Also read the directions in the **OMR Answer Sheet**. Fill in all the entries in the OMR Answer Sheet ***correctly***. **DO NOT WRITE/MARK ANYTHING EXCEPT IN THE SPACE PROVIDED FOR IT,** failing which your OMR Answer Sheet ***shall not*** be evaluated.
5. **Count** the number of **questions attempted** carefully and write it down in the space provided **in the OMR Answer Sheet.**
6. After you have completed filling in all your responses on the **OMR Answer Sheet** and the examination has concluded, **you should hand over** to the Invigilator **only the OMR Answer Sheet (in original). You are permitted to take away 2nd Copy of the OMR Answer Sheet and Test Booklet.**
7. Each question carries 1 mark.
8. Candidature would be cancelled in case of non-compliance with any of these instructions.
9. **Penalty for wrong answers :**

   THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBJECTIVE TYPE QUESTION PAPERS.

   (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, 0·5 mark of the marks assigned to that question will be deducted as penalty.

   (ii) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.

   (iii) If a question is left blank, i.e., no answer is given by the candidate, there will be no penalty for that question.
10. **"Mobile phones, calculators, IT gadgets, smart watch and any other electronic devices such as Bluetooth etc. are not allowed inside the premises where the examination is being conducted. Any infringements of these instructions shall entail disciplinary action including ban from future examinations."**

DO NOT OPEN THE SEAL UNTIL YOU ARE TOLD TO DO SO

SEAL

1. What is the force required to keep a 5 kg object moving with a constant velocity in the absence of friction?

(A) 0 N

(B) 5 N

(C) 10 N

(D) 50 N

2. A block of mass 0·1 kg is held against a wall applying a horizontal force of 5 N on the block. If the coefficient of friction between the block and the wall is 0·5, the magnitude of the friction force acting on the block is

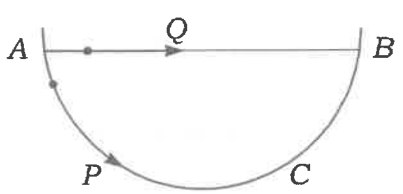
(A) 2·5 N

(B) 0·98 N

(C) 4·9 N

(D) 0·49 N

3. A particle P is sliding down a frictionless hemispherical bowl. It passes the point A at $t = 0$. At this instant of time, the horizontal component of its velocity is v. A bead Q of the same mass as P is ejected from A at $t = 0$ along the horizontal string AB with the speed v. Friction between the bead and the string may be neglected. Let t_P and t_Q be the respective times taken by P and Q to reach the point B. Then



(A) $t_P < t_Q$

(B) $t_P = t_Q$

(C) $t_P > t_Q$

(D) $\frac{t_P}{t_Q} = \frac{\text{Length of arc } ACB}{\text{Length of } AB}$

4. A particle with a momentum of 30 kgm/s has a mass of 5 kg. What is its kinetic energy?

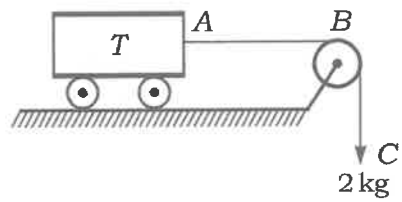
(A) 30 J

(B) 60 J

(C) 90 J

(D) 180 J

5. A trolley T of mass 5 kg on a horizontal smooth surface is pulled by a load of 2 kg through a uniform rope ABC of length 2 m and mass 1 kg as the load falls from $BC = 0$ to $BC = 2$ m. Its acceleration (in ms^{-2}) changes from



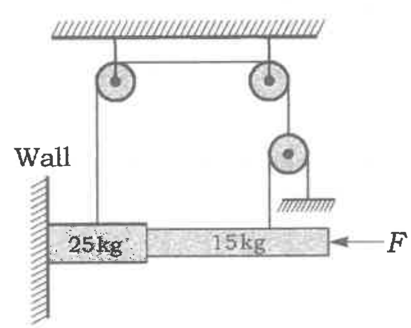
(A) $\frac{20}{6}$ to $\frac{30}{6}$

(B) $\frac{20}{8}$ to $\frac{30}{8}$

(C) $\frac{20}{5}$ to $\frac{30}{6}$

(D) None of the above

6. If the coefficient of friction between all surfaces (for the shown diagram) is 0·4, then find the minimum force F to have equilibrium of the system



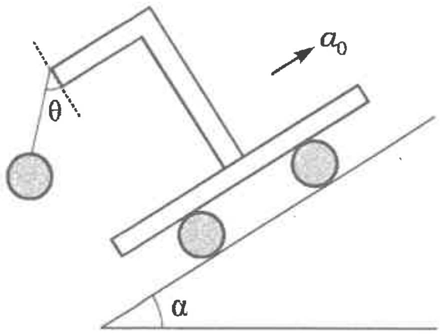
(A) 62·5 N

(B) 150 N

(C) 31·25 N

(D) 50 N

7. A pendulum of mass m hangs from a support fixed to a trolley. The direction of the string when the trolley rolls up a plane of inclination α with acceleration a_0 is



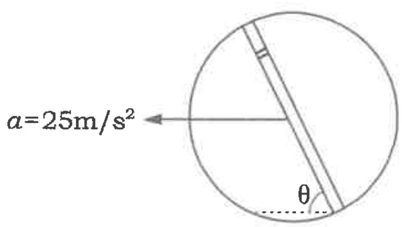
(A) $\theta = \tan^{-1} \alpha$

(B) $\theta = \tan^{-1}\left(\frac{a_0}{g}\right)$

(C) $\theta = \tan^{-1}\left(\frac{g}{a_0}\right)$

(D) $\theta = \tan^{-1}\left(\frac{a_0 + g\sin\alpha}{g\cos\alpha}\right)$

8. A circular disc with a groove along its diameter is placed horizontally. A block of mass 1 kg is placed as shown. The coefficient of friction between the block and all surfaces of groove in contact is $\mu = 2/5$. The disc has an acceleration of 25 m/s^2. Find the acceleration of the block with respect to disc.



$\cos\theta = 4/5 \quad \sin\theta = 3/5$

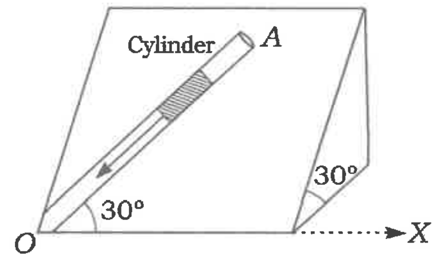
(A) 10 m/s^2

(B) 5 m/s^2

(C) 20 m/s^2

(D) 1 m/s^2

9. An inclined plane makes an angle 30° with the horizontal A groove (OA) of length = 5 m cut in the plane makes an angle 30° with OX. A short smooth cylinder is free to slide down under the influence of gravity. The time taken by the cylinder to reach from A to O is ($g = 10\ ms^{-2}$)



(A) 4 s

(B) 2 s

(C) 3 s

(D) 1 s

10. A 50 g bullet moving with velocity 10 m/s strikes a block of mass 950 g at rest and gets embedded in it. The loss in kinetic energy will be

(A) 100%

(B) 95%

(C) 5%

(D) 50%

11. A smooth sphere of mass M moving with velocity u directly collides elastically with another sphere of mass m at rest. After collision their final velocities are V and v respectively. The value of v is

(A) $\frac{2uM}{m}$

(B) $\frac{2um}{M}$

(C) $\frac{2u}{1+\frac{m}{M}}$

(D) $\frac{2u}{1+\frac{M}{m}}$

12. When a man increases his speed by 2 ms^{-1}, he finds that his kinetic energy is doubled. The original speed of the man is

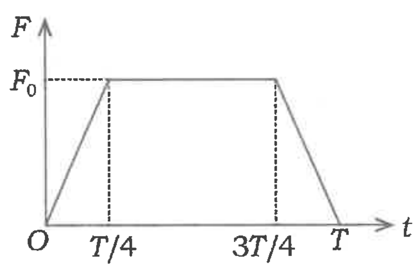
(A) $2(\sqrt{2}-1)\,ms^{-1}$

(B) $2(\sqrt{2}+1)\,ms^{-1}$

(C) $4{\cdot}5\ ms^{-1}$

(D) None of the above

13. A particle of mass m moving with a velocity u makes an elastic one-dimensional collision with a stationary particle of mass m establishing a contact with it for extremely small time T. Their force of contact increases from zero to F_0 linearly in time $T/4$ remains constant for a further time $T/2$ and decreases linearly from F_0 to zero in further time $T/4$ as shown. The magnitude possessed by F_0 is



(A) $\frac{mu}{T}$

(B) $\frac{2mu}{T}$

(C) $\frac{4mu}{3T}$

(D) $\frac{3mu}{4T}$

14. 1 kg body explodes into three fragments. The ratio of their masses is 1 : 1 : 3. The fragments of same mass move perpendicular to each other with speed 30 ms^{-1}, while the heavier part remains in the initial direction. The speed of heavier part is

(A) $\frac{10}{\sqrt{2}}\,ms^{-1}$

(B) $10\sqrt{2}\,ms^{-1}$

(C) $20\sqrt{2}\,ms^{-1}$

(D) $30\sqrt{2}\,ms^{-1}$

15. Two thin uniform circular rings each of radius 10 cm and mass 0·1 kg are arranged such that they have a common centre and their planes are perpendicular to each other. The moment of inertia of this system about an axis passing through their common centre and perpendicular to the plane of one of the rings in kgm^{-2} is

(A) 15×10^{-3}

(B) 5×10^{-3}

(C) $1{\cdot}5 \times 10^{-3}$

(D) 18×10^{-4}

16. If the angular momentum of a rotating body about a fixed axis is increased by 10%, then its kinetic energy will be increased by

(A) 10%

(B) 20%

(C) 21%

(D) 5%

17. The speed of a homogeneous solid sphere after rolling down an inclined plane of vertical height h from rest without sliding is

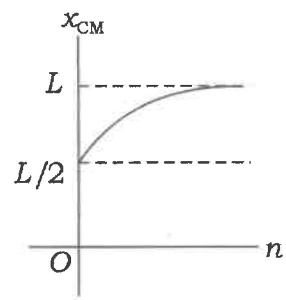
(A) $\sqrt{\frac{10}{7} g h}$

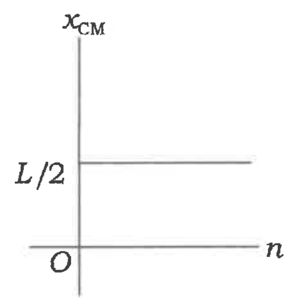
(B) $\sqrt{\frac{4}{3} g h}$

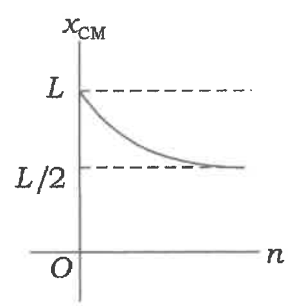
(C) $\sqrt{g h}$

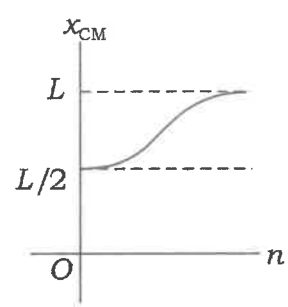
(D) $\sqrt{\frac{6g h}{5}}$

18. A thin rod of length L is lying along the x-axis with its ends at $x = 0$ and $x = L$. Its linear density (mass/length) varies with x as $k\left(\frac{x}{L}\right)^n$, where n can be zero or any positive number. If the position x_{CM} of the centre of mass of the rod is plotted against n, which of the following graphs best approximates the dependence of x_{CM} on n?

(A) 

(B) 

(C) 

(D) 

19. The position of a particle is given by $\vec{r} = \left(\hat{i} + 2\hat{j} - \hat{k}\right)$ and momentum $\vec{P} = \left(3\hat{i} + 4\hat{j} - 2\hat{k}\right)$. The angular momentum is perpendicular to

(A) X-axis

(B) Y-axis

(C) Z-axis

(D) Line at equal angles to all the three axes

20. A particle performs uniform circular motion with an angular momentum L. If the frequency of particle's motion is doubled and its KE is halved, then the angular momentum becomes

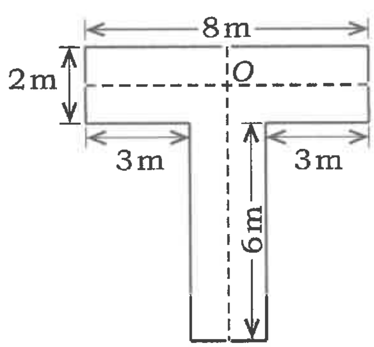
(A) $\frac{L}{2}$

(B) $2L$

(C) $4L$

(D) $\frac{L}{4}$

21. The distance of the centre of mass of the T-shaped plate from O is



(A) 7 m

(B) 2·7 m

(C) 4 m

(D) 1 m

22. A small object of mass m is attached to a light string which passes through a hollow tube. The tube is hold by one hand and the string by the other. The object is set into rotation in a circle of radius R and velocity v. The string is then pulled down shortening the radius of path r. What is conserved?

(A) Angular momentum

(B) Linear momentum

(C) Kinetic energy

(D) None of the above

23. Particles of masses m, $2m$, $3m$, ..., nm grams are placed on the same line at distances l, $2l$, $3l$, ..., nl cm from a fixed point. The distance of centre of mass of the particles from the fixed point in centimeters is

(A) $\frac{(2n+1)\,l}{3}$

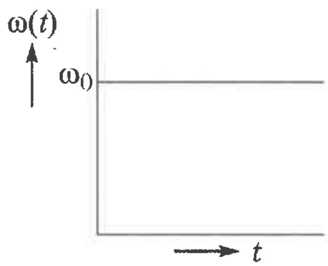
(B) $\frac{l}{n+1}$

(C) $\frac{n\,(n^2+1)\,l}{2}$

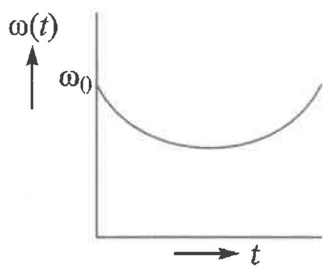
(D) $\frac{2l}{n(n^2+1)}$

24. A circular platform is free to rotate in a horizontal plane about a vertical axis passing through its centre. A tortoise is sitting at the edge of the platform. Now the platform is given an angular velocity ω_0. When the tortoise moves along a chord of the platform with a constant velocity (w.r.t. the platform), the angular velocity of the platform will vary with the time t as

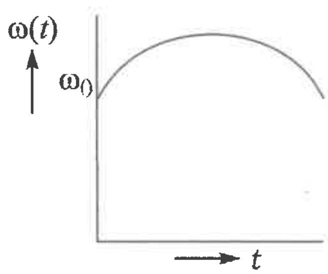
(A)



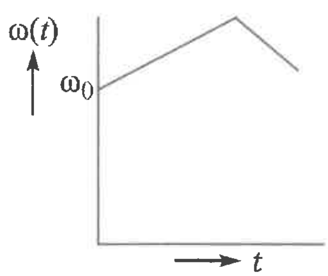
(B)



(C)



(D)



25. A flywheel of moment of inertia 3×10^2 kg m^2 is rotating with uniform angular speed of 4·6 rad s^{-1}. If a torque of $6{\cdot}9 \times 10^2$ Nm retards the wheel, then the time in which the wheel comes to rest is

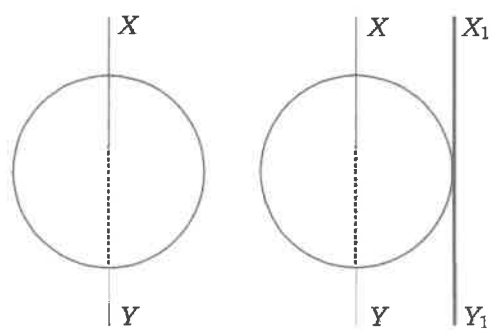
(A) 1·5 s

(B) 2 s

(C) 0·5 s

(D) 1 s

26. The moment of inertia of a circular disc of radius 2 m and mass 1 kg about an axis passing through the centre of mass but perpendicular to the plane of the disc is 2 kg m^2. Its moment of inertia about an axis parallel to this axis but passing through the edge of the disc is (shown in the given figure)



(A) 8 kgm^2

(B) 4 kgm^2

(C) 10 kgm^2

(D) 6 kgm^2

27. Four particles each of mass m are lying symmetrically on the rim of a disc of mass M and radius R. Moment of inertia of this system about an axis passing through one of the particles and perpendicular to plane of disc is

(A) $16\ mR^2$

(B) $(3M+16m)\frac{R^2}{2}$

(C) $(3M+12m)\frac{R^2}{2}$

(D) zero

28. A solid sphere of mass 500 g and radius 10 cm rolls without slipping with the velocity 20 cm/s. The total kinetic energy of the sphere will be

(A) 0·014 J

(B) 0·028 J

(C) 280 J

(D) 140 J

29. A thin uniform square lamina of side a is placed in the xy-plane with its sides parallel to x-axis and y-axis and with its centre coinciding with origin. Its moment of inertia about an axis passing through a point on the y-axis at a distance $y = 2a$ and parallel to x-axis is equal to its moment of inertia about an axis passing through a point on the x-axis at a distance $x = d$ and perpendicular to xy-plane. Then value of d is

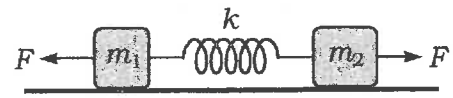
(A) $\frac{7}{3}a$

(B) $\sqrt{\frac{47}{12}}a$

(C) $\frac{9}{5}a$

(D) $\sqrt{\frac{51}{12}}a$

30. In the given figure, two bodies of mass m_1 and mass m_2 are connected by massless spring of force constant k and are placed on a smooth surface (shown in the figure), then



(A) The acceleration of centre of mass must be zero at every instant

(B) The acceleration of centre of mass may be zero at every instant

(C) The system always remains in rest

(D) None of the above

31. A horizontal platform is rotating with uniform angular velocity around the vertical axis passing through its centre. At some instant of time a viscous fluid of mass m is dropped at the centre and is allowed to spread out and finally fall. The angular velocity during this period

(A) decreases continuously

(B) decreases initially and increases again

(C) remains unaltered

(D) increases continuously

32. Out of the given bodies (of same mass) for which the moment of inertia will be maximum about the axis passing through its centre of gravity and perpendicular to its plane?

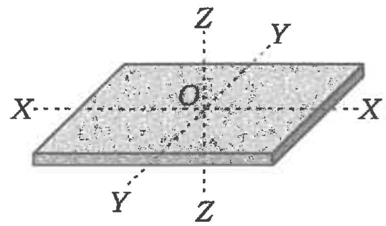
(A) Disc of radius a

(B) Ring of radius a

(C) Square lamina of side $2a$

(D) Four rods of length $2a$ making a square

33. The rectangular block shown in the figure is rotated in turn about $x-x$, $y-y$ and $z-z$ axes passing through its centre of mass O. Its moment of inertia is



(A) same about all the three axes

(B) maximum about $z-z$ axis

(C) equal about $x-x$ and $y-y$ axes

(D) maximum about $y-y$ axis

34. A uniform rod of length L and mass 1·8 kg is made to rest on two measuring scales at its two ends. A uniform block of mass 2·7 kg is placed on the rod at a distance $L/4$ from the left end. The force experienced by the measuring scale on the right end is

(A) 18 N

(B) 27 N

(C) 29 N

(D) 45 N

35. The moment of inertia of a flywheel having kinetic energy 360 J and angular speed of 20 rad/s is

(A) 18 kgm^2

(B) 1·8 kgm^2

(C) 2·5 kgm^2

(D) 9 kgm^2

36. The angular momentum of a wheel changes from $2L$ to $5L$ in 3 seconds. What is the magnitude of the torque acting on it?

(A) L

(B) $L/2$

(C) $L/3$

(D) $L/5$

37. Moment of inertia of ring about its diameter is l. Then, moment of inertia about an axis passing through centre perpendicular to its plane is

(A) $2l$

(B) $\frac{l}{2}$

(C) $\frac{3}{2}l$

(D) l

38. Two bodies have their moments of inertia l and $2l$ respectively about their axes of rotation. If their kinetic energies of rotation are equal, then their angular momentum will be in the ratio

(A) 1 : 2

(B) $\sqrt{2}:1$

(C) 2 : 1

(D) $1:\sqrt{2}$

39. A wheel rotates with a constant angular velocity of 300 r.p.m. The angle through which the wheel rotates in 1 s is

(A) π rad

(B) 5π rad

(C) 10π rad

(D) 20π rad

40. Identify the increasing order of the angular velocities of the following :

(i) Earth rotating about its own axis

(ii) Hour's hand of a clock

(iii) Second's hand of a clock

(iv) Flywheel of radius 2 m making 300 r.p.m.

(A) *(i), (ii), (iii), (iv)*

(B) *(ii), (iii), (iv), (i)*

(C) *(iii), (iv), (i), (ii)*

(D) *(iv), (i), (ii), (iii)*

41. A ball strikes a horizontal floor at an angle $\theta = 45°$. The coefficient of restitution between the ball and the floor is $e = 1/2$. The fraction of its kinetic energy lost in collision is

(A) 5/8

(B) 3/8

(C) 3/4

(D) 1/4

42. A force of 200 N acts tangentially on the rim of a wheel 25 cm in radius. Find the torque.

(A) 50 Nm

(B) 150 Nm

(C) 75 Nm

(D) 39 Nm

43. Consider an iron rod of length 1 m and cross-section 1 cm^2 with a Young's modulus of 10^{12} dyne cm^{-2}. We wish to calculate the force with which the two ends must be pulled to produce an elongation of 1mm. It is equal to

(A) 10^9 dyne

(B) 10^8 dyne

(C) 10^6 dyne

(D) 10^{17} dyne

44. The upper end of a wire 1 m long and 2 mm radius is clamped. The lower end is twisted through an angle of 45°. The angle of shear is

(A) 0·09°

(B) 0·9°

(C) 9°

(D) 90°

45. The average depth of Indian Ocean is about 3000 m. The fractional compression, $\frac{\Delta V}{V}$ of water at the bottom of the ocean (given that the bulk modulus of the water = $2{\cdot}2 \times 10^9$ Nm^{-2} and $g = 10$ ms^{-2}) is

(A) 0·82%

(B) 0·91%

(C) 1·36%

(D) 1·24%

46. Bulk modulus of water is 2×10^9 Nm^{-2}. The change in pressure required to increase the density of water by 0·1% is

(A) 2×10^9 Nm^{-2}

(B) 2×10^8 Nm^{-2}

(C) 2×10^6 Nm^{-2}

(D) 2×10^4 Nm^{-2}

47. A wire elongates by l mm when a load W is hanged from it. If the wire goes over a pulley and two weights W each are hung at the two ends, the elongation of the wire will be (in mm)

(A) l

(B) $2l$

(C) zero

(D) $\frac{l}{2}$

48. A metallic ring of radius r and cross-sectional area A is fitted into a wooden circular disc of radius $R(R > r)$. If the Young's modulus of the material of the ring is Y, then the force with which the metal ring expands is

(A) $\frac{AYR}{r}$

(B) $\frac{AY(R-r)}{r}$

(C) $\frac{Y(R-r)}{Ar}$

(D) $\frac{YR}{AR}$

49. The upper end of a wire of radius 4 mm and length 100 cm is clamped and its other end is twisted through an angle of 30°. Then angle of shear is

(A) 0·012°

(B) 0·12°

(C) 1·2°

(D) 12°

50. A 2 m long rod of radius 1 cm which is fixed from one end is given a twist of 0·8 radians. The shear strain developed will be

(A) 0·002

(B) 0·004

(C) 0·008

(D) 0·016

51. A wire suspended vertically from one of its ends is stretched by attaching a weight of 200 N to the lower end. The weight stretches the wire by 1 mm. Then, the elastic energy stored in the wire is

(A) 0·2 J

(B) 10 J

(C) 20 J

(D) 0·1 J

52. A height spring extends 40 mm when stretched by a force of 10 N and for tensions up to this value the extension is proportional to the stretching force. Two such springs are joined end-to-end and the double-length spring is stretched 40 mm beyond its natural length. The total strain energy (in joule), stored in the double spring is

(A) 0·05

(B) 0·10

(C) 0·80

(D) 0·40

53. A body floats in a liquid contained in a beaker. If the whole system falls under gravity, then the upthrust on the body due to liquids is

(A) equal to the weight of the body in air

(B) equal to the weight of the body in liquid

(C) zero

(D) equal to the weight of the immersed part of the body

54. A raindrop of radius 1·5 mm experiences a drag force $F = (2 \times 10^{-5}\, v)$ N, while falling through air from a height 2 km with a velocity v. The terminal velocity of the raindrop will be nearly (use $g = 10$ ms^{-2})

(A) 200 ms^{-1}

(B) 80 ms^{-1}

(C) 7 ms^{-1}

(D) 3 ms^{-1}

55. A raindrop of radius 0·3 mm has a terminal velocity in air = 1 ms^{-1}. The viscous force on it is

(A) $101{\cdot}73 \times 10^{-4}$ dyne

(B) $101{\cdot}73 \times 10^{-5}$ dyne

(C) $16{\cdot}95 \times 10^{-4}$ dyne

(D) $16{\cdot}95 \times 10^{-5}$ dyne

56. A rectangular vessel when full of water takes 10 min. to be emptied through an orifice in its bottom. How much time will take to be emptied when half filled with water?

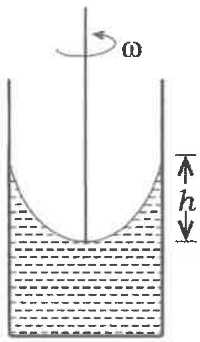
(A) 9 min.

(B) 7 min.

(C) 5 min.

(D) 3 min.

57. A liquid is kept in a cylindrical vessel which is rotated along its axis. The liquid rises at the sides (figure). If the radius of the vessel is 0·05 m and the speed of rotation is 2 rad s^{-1}. Find the difference in the height of the liquid at the centre of the vessel and its sides.



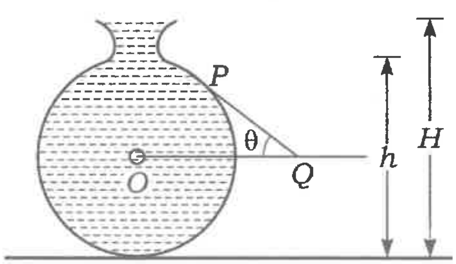
(A) 20 cm

(B) 4 cm

(C) 2 cm

(D) 0·2 cm

58. Figure shows the vertical cross-section of a vessel filled with a liquid of density ρ. The normal thrust per unit area on the walls of the vessel at point P as shown will be



(A) $h\rho g$

(B) $H\rho g$

(C) $(H-h)\rho g$

(D) $(H-h)\rho g \cos\theta$

59. The density ρ of water of bulk modulus B at a depth y in the ocean is related to the density at surface ρ_0 by the relation

(A) $\rho = \rho_0\left[1 - \frac{\rho_0 g y}{B}\right]$

(B) $\rho = \rho_0\left[1 + \frac{\rho_0 g y}{B}\right]$

(C) $\rho = \rho_0\left[1 + \frac{B}{\rho_0 h g y}\right]$

(D) $\rho = \rho_0\left[1 - \frac{B}{\rho_0 g y}\right]$

60. An iceberg of density 900 kg/m^3 is floating in water of density 1000 kg/m^3. The percentage of volume of ice cube outside the water is

(A) 20%

(B) 35%

(C) 10%

(D) 25%

61. A small spherical ball falling through a viscous medium of negligible density has terminal velocity v. Another ball of the same mass but of radius twice that of the earlier falling through the same viscous medium will have terminal velocity

(A) v

(B) $\frac{v}{4}$

(C) $\frac{v}{2}$

(D) $2v$

62. A block of aluminium of mass 1 kg and volume $3 \cdot 6 \times 10^{-4}$ m^3 is suspended from a string and then completely immersed in a container of water. The decrease in tension in the string after immersion is

(A) 9·8 N

(B) 6·2 N

(C) 3·6 N

(D) 1·0 N

63. If the work done in blowing a bubble of volume V is W, then the work done in blowing a soap bubble of volume $2V$ will be

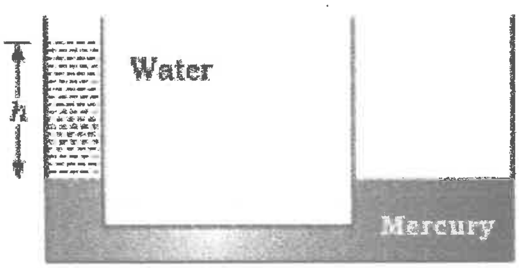
(A) W

(B) $2W$

(C) $\sqrt{2}\,W$

(D) $4^{1/3}\,W$

64. Two communicating vessels contain mercury. The diameter of one vessel is n times larger than the diameter of the other. A column of water of height h is poured into the left vessel. The mercury level will rise in the right-hand vessel (s = relative density of mercury and ρ = density of water) by



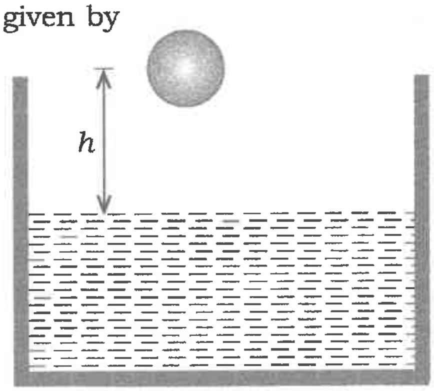
(A) $\dfrac{n^2 h}{(n+1)^2 s}$

(B) $\dfrac{h}{(n^2+1)s}$

(C) $\dfrac{h}{(n+1)^2 s}$

(D) $\dfrac{h}{n^2 s}$

65. A ball of radius r and density ρ falls freely under gravity through a distance h before entering water. Velocity of ball does not change even on entering water. If viscosity of water is η, then the value of h is given by



(A) $\dfrac{2}{9} r^2 \left(\dfrac{1-\rho}{\eta}\right) g$

(B) $\dfrac{2}{81} r^2 \left(\dfrac{\rho-1}{\eta}\right) g$

(C) $\dfrac{2}{81} r^4 \left(\dfrac{\rho-1}{\eta}\right)^2 g$

(D) $\dfrac{2}{9} r^4 \left(\dfrac{\rho-1}{\eta}\right)^2 g$

66. From a steel wire of density ρ is suspended a brass block of density ρ_B. The extension of steel wire comes to l. If the brass block is now fully immersed in a liquid of density ρ_L, the extension becomes l'. The ratio l/l' will be

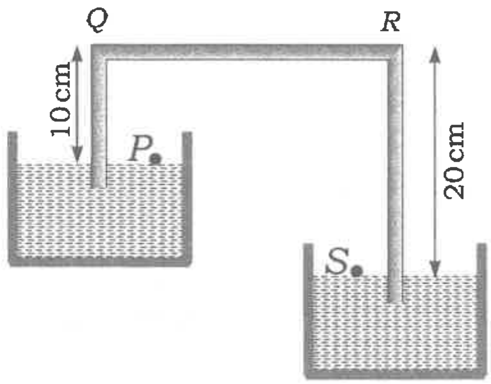
(A) $\dfrac{\rho_B - \rho}{\rho_L - \rho}$

(B) $\dfrac{\rho_L}{\rho_B - \rho_L}$

(C) $\dfrac{\rho_B - \rho_L}{\rho_B}$

(D) $\dfrac{\rho_B}{\rho_B - \rho_L}$

67. A siphon in use is demonstrated in the following figure. The density of the liquid flowing in siphon is 1·5 gm/cc. The pressure difference between the points P and S will be



(A) 10^5 N/m

(B) 2×10^5 N/m

(C) zero

(D) infinity

68. A hole is in the bottom of a tank having water. If total pressure at bottom is 3 atm (1 atm = 10^5 Nm^{-2}), then velocity of water flowing from hole is

(A) $\sqrt{400}\ \text{ms}^{-1}$

(B) $\sqrt{600}\ \text{ms}^{-1}$

(C) $\sqrt{60}\ \text{ms}^{-1}$

(D) None of the above

69. A large tank filled with water to a height h is to be emptied through a small hole at the bottom. The ratio of times taken for the level of water to fall from h to $h/2$ and $h/2$ to zero is

(A) $\sqrt{2}$

(B) $\frac{1}{\sqrt{2}}$

(C) $\sqrt{2}-1$

(D) $\frac{1}{\sqrt{2}-1}$

70. Speed of 2 cm radius ball in a viscous liquid is 20 cms^{-1}. Then the speed of 1 cm radius ball in the same liquid is

(A) 5 cms^{-1}

(B) 10 cms^{-1}

(C) 40 cms^{-1}

(D) 80 cms^{-1}

71. The fraction of a floating object of volume V_0 and density d_0 above the surface of a liquid of density d will be

(A) $\frac{d_0}{d}$

(B) $\frac{dd_0}{d+d_0}$

(C) $\frac{d-d_0}{d}$

(D) $\frac{dd_0}{d-d_0}$

72. A body of density d_1 is counterpoised by Mg of weights of density d_2 in air of density d. Then the true mass of the body is

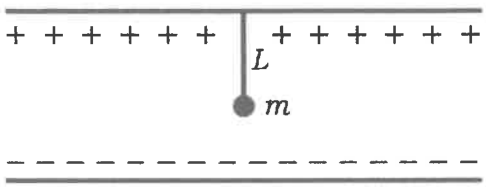
(A) M

(B) $M\left(1-\frac{d}{d_2}\right)$

(C) $M\left(1-\frac{d}{d_1}\right)$

(D) $\frac{M(1-d/d_2)}{(1-d/d_1)}$

73. A small sphere carrying a charge q is hanging in between two parallel plates by a string of length L. Time period of pendulum is T_0. When parallel plates are charged, the time period changes to T. The ratio T/T_0 is equal to



(A) $\left(\dfrac{g+\dfrac{qE}{m}}{g}\right)^{1/2}$

(B) $\left(\dfrac{g}{g+\dfrac{qE}{m}}\right)^{3/2}$

(C) $\left(\dfrac{g}{g+\dfrac{qE}{m}}\right)^{1/2}$

(D) None of the above

74. The bob of a simple pendulum executes simple harmonic motion in water with a period t, while the period of oscillation of the bob is t_0 in air. Neglecting frictional force of water and given that the density of the bob is $(4/3 \times 1000\ \text{kg - m}^3)$. What relationship between t and t_0 is ***true***?

(A) $t = t_0$

(B) $t = t_0/2$

(C) $t = 2t_0$

(D) $t = 4t_0$

75. Two simple pendulums of length 0·5 m and 20 m respectively are given small linear displacement in one direction at the same time. They will again be in the phase when the pendulum of shorter length has completed _____ oscillation(s).

(A) 5

(B) 1

(C) 2

(D) 3

76. A body has a time period T_1 under the action of one force and T_2 under the action of another force. The square of the time period when both the forces are acting in the same direction is

(A) $T_1^2 T_2^2$

(B) T_1^2 / T_2^2

(C) $T_1^2 + T_2^2$

(D) $T_1^2 T_2^2 / (T_1^2 + T_2^2)$

77. A mass of 4 kg suspended from a spring of force constant 800 Nm^{-1} executes simple harmonic oscillations. If the total energy of the oscillator is 4 J, then the maximum acceleration (in ms^{-2}) of the mass is

(A) 5

(B) 15

(C) 45

(D) 20

78. A spring of force constant k is cut into two pieces such that one piece is double the length of the other. Then the long piece will have a force constant of

(A) $(2/3)k$

(B) $(3/2)k$

(C) $3k$

(D) $6k$

79. The amplitude of vibration of a particle is given by $a_m = (a_0)/(a\omega^2 - b\omega + c)$; where a_0, a, b and c are positive. The condition for a single resonant frequency is

(A) $b^2 = 4ac$

(B) $b^2 > 4ac$

(C) $b^2 = 5ac$

(D) $b^2 = 7ac$

80. Starting from the origin a body oscillates simple harmonically with a period of 2 s. After what time will its kinetic energy be 75% of the total energy?

(A) $\frac{1}{6}$ s

(B) $\frac{1}{4}$ s

(C) $\frac{1}{3}$ s

(D) $\frac{1}{12}$ s

81. A particle is vibrating in a simple harmonic motion with an amplitude of 4 cm. At what displacement from the equilibrium position is its energy half potential and half kinetic?

(A) 1 cm

(B) $\sqrt{2}$ cm

(C) 3 cm

(D) $2\sqrt{2}$ cm

82. A simple pendulum has a time period T_1 when on the earth's surface and T_2 when taken to a height $2R$ above the earth's surface where R is the radius of the earth. The value of (T_1/T_2) is

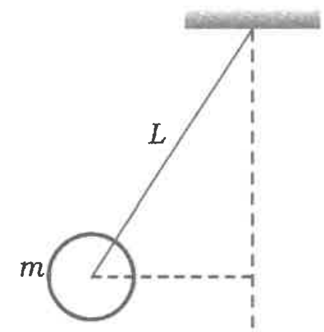
(A) 1/9

(B) 1/3

(C) $\sqrt{3}$

(D) 3

83. A ball of mass (m) 0·5 kg is attached to the end of a string having length (L) 0·5 m. The ball is rotated on a horizontal circular path about vertical axis. The maximum tension that the string can bear is 324 N. The maximum possible value of angular velocity of ball (in radian/s) is



(A) 9

(B) 18

(C) 27

(D) 36

84. Two wires made up of same material are of equal lengths but their radii are in the ratio 1 : 2. On stretching each of these two string by the same tension, the ratio between the fundamental frequencies is

(A) 1 : 2

(B) 2 : 1

(C) 1 : 4

(D) 4 : 1

85. The frequency and velocity of sound wave are 600 Hz and 360 m/s respectively. Phase difference between two particles of medium are 60°, the minimum distance between these two particles will be

(A) 10 cm

(B) 15 cm

(C) 20 cm

(D) 50 cm

86. Two identical flutes produce fundamental notes of frequency 300 Hz at 27 °C. If the temperature of air in one flute is increased to 31 °C, then the number of the beats heard per second will be

(A) 1

(B) 2

(C) 3

(D) 4

87. When beats are produced by two progressive waves of the same amplitude and of nearly the same frequency, the ratio of maximum loudness to the loudness of one of the waves will be n, where n is

(A) 3

(B) 1

(C) 4

(D) 2

88. The displacement y of a particle in a medium can be expressed as $y = 10^{-6} \sin\left(100t + 20x + \frac{\pi}{4}\right)$ m, where t is in second and x in metre. The speed of the wave is

(A) 2000 ms^{-1}

(B) 5 ms^{-1}

(C) 20 ms^{-1}

(D) 5π ms^{-1}

89. A whistle giving out 450 Hz approaches a stationary observer at a speed of 33 ms^{-1}. The frequency heard by the observer in Hz is [velocity of sound in air = 333 ms^{-1}]

(A) 409

(B) 429

(C) 517

(D) 500

90. Vibrating tuning fork of frequency n is placed near the open end of a long cylindrical tube. The tube has a side opening and is fitted with a movable reflecting piston. As the piston is moved through 8·75 cm, the intensity of sound changes from a maximum to minimum. If the speed of sound is 350 m/s. then n is

(A) 500 Hz

(B) 1000 Hz

(C) 2000 Hz

(D) 4000 Hz

91. The length of a sonometer wire tuned to a frequency of 250 Hz is 0·60 metre. The frequency of tuning fork with which the vibrating wire will be in tune when the length is made 0·40 metre is

(A) 250 Hz

(B) 375 Hz

(C) 256 Hz

(D) 384 Hz

92. Transverse waves of same frequency are generated in two steel wires A and B. The diameter of A is twice of B and the tension in A is half that in B. The ratio of velocities of wave in A and B is

(A) $1:3\sqrt{2}$

(B) $1:2\sqrt{2}$

(C) $1:2$

(D) $\sqrt{2}:1$

93. The phase difference between two points separated by 0·8 m in a wave of frequency is 120 Hz is $\pi/2$. The velocity of wave is

(A) 720 m/s

(B) 384 m/s

(C) 250 m/s

(D) 1 m/s

94. In a resonance column, first and second resonances are obtained at depths 22·7 cm and 70·2 cm. The third resonance will be obtained at a depth

(A) 117·7 cm

(B) 92·9 cm

(C) 115·5 cm

(D) 113·5 cm

95. Equation of a progressive wave is given by

$$y = 0{\cdot}2\cos\pi\left(0{\cdot}04t + 0{\cdot}02x - \frac{\pi}{6}\right)$$

The distance is expressed in cm and time in second. What will be the minimum distance between two particles having the phase difference of $\pi/2$?

(A) 4 cm

(B) 8 cm

(C) 25 cm

(D) 12·5 cm

96. A tuning fork *A* produces 4 beats/sec with another tuning fork *B* of frequency 320 Hz. On filing the fork *A*, 4 beats/sec are again heard. The frequency of fork *A* after filing is

(A) 324 Hz

(B) 320 Hz

(C) 316 Hz

(D) 314 Hz

97. Two stretched strings of same material are vibrating under same tension in fundamental mode. The ratio of their frequencies is 1 : 2 and ratio of the length of the vibrating segments is 1 : 4. Then the ratio of the radii of the strings is

(A) 2 : 1

(B) 4 : 1

(C) 3 : 2

(D) 8 : 1

98. A band playing music at a frequency f is moving towards a wall at a speed v_b. A motorist is following the band with a speed v_m. If v is speed of sound, then the expression for the beat frequency heard by the motorist is

(A) $\dfrac{(v+v_m)f}{v+v_b}$

(B) $\dfrac{(v+v_m)f}{v-v_b}$

(C) $\dfrac{2v_b(v+v_m)f}{v^2-v_b^2}$

(D) $\dfrac{2v_m(v+v_b)f}{v^2-v_b^2}$

99. A wave is given by $y = 3\sin 2\pi\left(\dfrac{t}{0{\cdot}04} - \dfrac{x}{0{\cdot}01}\right)$, where y is in cm. Frequency of wave and maximum acceleration of particle will be

(A) 100 Hz, $4{\cdot}7 \times 10^3$ cm/s^2

(B) 500 Hz, $7{\cdot}5 \times 10^3$ cm/s^2

(C) 25 Hz, $4{\cdot}7 \times 10^4$ cm/s^2

(D) 25 Hz, $7{\cdot}4 \times 10^4$ cm/s^2

100. A sound wave of frequency f propagating through air with a velocity c is reflected from a surface which is moving away from the source with a constant speed v. the frequency of the reflected wave measured by the observed at the position of the source is

(A) $\dfrac{f(c-v)}{c+v}$

(B) $\dfrac{f(c+v)}{c-v}$

(C) $\dfrac{f(c+2v)}{c+v}$

(D) $\dfrac{f(c-v)}{c-2v}$

101. If $y = 5\sin\left(30\pi t - \dfrac{\pi}{7} + 30°\right) y \to mm,$

$t \to s,\ x \to m$ for given progressive wave equation. Phase difference between two vibrating particles having path difference 3·5 m would be

(A) $\pi/4$

(B) π

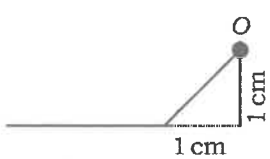
(C) $\pi/3$

(D) $\pi/2$

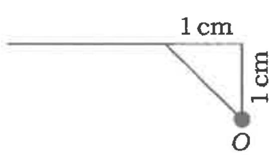
102. In the question, the shape of the wave at time $t = 3$s, if O is a fixed end (not free) in is

(A)

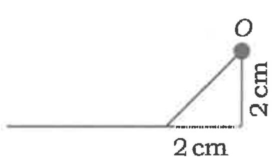
(B)



(C)



(D)



103. A cylindrical tube open at both the ends has a fundamental frequency of 390 Hz in air. If $\dfrac{1}{4}$ of the tube is immersed vertically in water the fundamental frequency of air column is

(A) 260 Hz

(B) 130 Hz

(C) 390 Hz

(D) 520 Hz

104. A motor car is approaching towards a crossing with a velocity of 72 kmh^{-1}. The frequency of sound of its horn as heard by a policeman standing on the crossing is 260 Hz. The frequency of the horn is

(A) 200 Hz

(B) 244 Hz

(C) 150 Hz

(D) 80 Hz

105. If V_m is the velocity of sound in moist air and V_d is the velocity of sound in dry air under identical conditions of pressure and temperature, then

(A) $V_m < V_d$

(B) $V_m > V_d$

(C) $V_m V_d = 1$

(D) $V_m = V_d$

106. A plano-convex lens of ($f = 20$ cm) is silvered at plane surface. New f will be

(A) 20 cm

(B) 40 cm

(C) 30 cm

(D) 10 cm

107. The plane faces of two identical plano-convex lenses each having a focal length of 50 cm are placed against each other to form a usual biconvex lens. The distance from this lens combination at which an object must be placed to obtain a real, inverted image which has the same size as the object is

(A) 50 cm

(B) 25 cm

(C) 100 cm

(D) 40 cm

108. An astronomical telescope has objective and eye-piece lenses of powers 0·5D and 20D respectively. What will be its magnifying power?

(A) 30

(B) 10

(C) 40

(D) 20

109. The focal lengths of the objective and eye lenses of a microscope are 1·6 cm and 2·5 cm respectively. The distance between the two lenses is 21·7 cm. If the final image is formed at infinity, then the distance between the object and the objective lens is

(A) 1·8 cm

(B) 1·70 cm

(C) 1·65 cm

(D) 1·75 cm

110. A symmetric double convex lens is cut into two equal parts by a plane perpendicular to the principle axis. If the power of the original lens is 4D, then the power of a cut lens will be

(A) 2D

(B) 3D

(C) 4D

(D) 5D

111. A lens made of glass whose index of refraction is 1·60 has a focal length of +20 cm in air. Its focal length in water whose refractive index is 1·33 will be

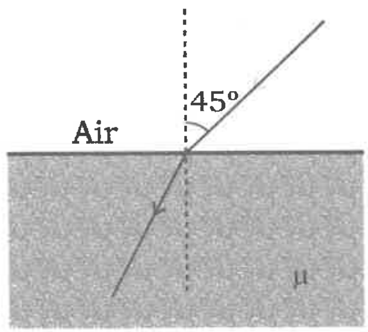
(A) three times longer than in air

(B) two times longer than in air

(C) same as in air

(D) None of the above

112. In the figure shown for an angle of incidence 45° at the top surface what is the minimum refractive index needed for total internal reflection at vertical face?



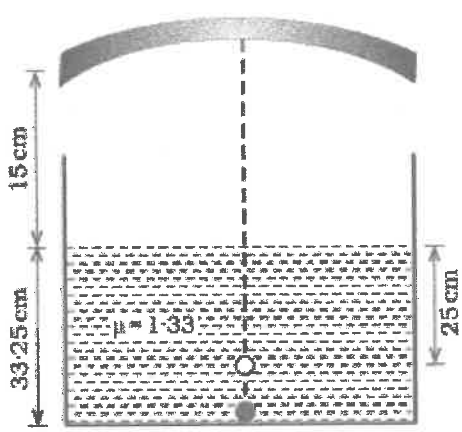
(A) $\frac{\sqrt{2}+1}{2}$

(B) $\sqrt{\frac{3}{2}}$

(C) $\sqrt{\frac{1}{2}}$

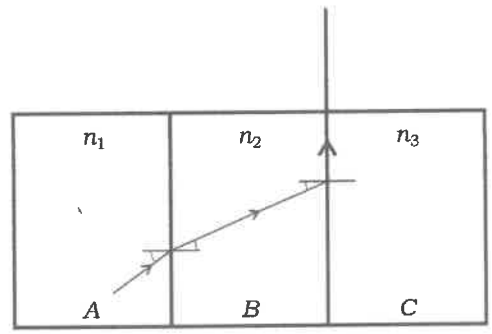
(D) $\sqrt{2}+1$

113. A container is filled with water ($\mu = 1{\cdot}33$) up to a height of 33·25 cm. A concave mirror is placed 15 cm above the water level and the image of an object placed at the bottom is formed 25 cm below the water level. The focal length of the mirror is



(A) 10 cm
(B) 15 cm
(C) 20 cm
(D) 25 cm

114. A, B and C are the parallel sided transparent media of refractive indices n_1, n_2 and n_3 respectively. They are arranged as shown in the figure. A ray is incident at an angle i on the surface of separation of A and B which is as shown in the figure. After the refraction into the medium B the ray grazes the surface of separation of the media B and C. Then, sin i equal to



(A) $\frac{n_3}{n_1}$

(B) $\frac{n_1}{n_3}$

(C) $\frac{n_2}{n_3}$

(D) $\frac{n_1}{n_2}$

115. An object is placed 30 cm to the left of a diverging lens whose focal length is of magnitude 20 cm. Which one of the following ***correctly*** states the nature and position of the virtual image formed?

	Nature of image	Distance from lens
(A)	Inverted, enlarged	60 cm to the right
(B)	Erect, diminished	12 cm to the left
(C)	Inverted, enlarged	60 cm to the left
(D)	Erect, diminished	12 cm to the right

116. A beaker containing liquid is placed on a table underneath a microscope which can be moved along a vertical scale. The microscope is focused through the liquid onto a mark on the table when the reading on the scale is a. It is next focused on the upper surface of the liquid and the reading is b. More liquid is added and the observations are repeated the corresponding readings are c and d. The refractive index of the liquid is

(A) $\frac{d-b}{d-c-b+a}$

(B) $\frac{b-d}{d-c-b+a}$

(C) $\frac{d-c-b+a}{d-b}$

(D) $\frac{d-b}{a+b-c-d}$

117. A square card of side length 1 mm is being seen through a magnifying lens of focal length 10 cm. The card is placed at a distance of 9 cm from the lens. The apparent area of the card through the lens is

(A) 1 cm^2

(B) 0·81 cm^2

(C) 0·27 cm^2

(D) 0·60 cm^2

118. The focal length of objective and eye-piece of a microscope are 1 cm and 5 cm respectively. If the magnifying power for relaxed eye is 45, then length of the tube is

(A) 9 cm

(B) 15 cm

(C) 12 cm

(D) 6 cm

119. A circular disc is placed in front of a narrow source. When the point of observation is at a distance of 1 meter from the disc, then the disc covers first HPZ. The intensity at this point is I_0. The intensity at a point distance 25 cm from the disc will be (If ratio of consecutive amplitude of HPZ is 0·9)

(A) $I_1 = 0{\cdot}531 I_0$

(B) $I_1 = 0{\cdot}053 I_0$

(C) $I_1 = 53 I_0$

(D) $I_1 = 5{\cdot}03 I_0$

120. In Young's double slit experiment intensity at a point is (1/4) of the maximum intensity. Angular position of this point is

(A) $\sin^{-1}(\lambda/d)$

(B) $\sin^{-1}(\lambda/2d)$

(C) $\sin^{-1}(\lambda/3d)$

(D) $\sin^{-1}(\lambda/4d)$

121. In a YDSE bi-chromatic light of wavelengths 400 nm and 560 nm are used. The distance between the slits is 0·1 mm and the distance between the plane of the slits and the screen is 1 m. The minimum distance between two successive regions of complete darkness is

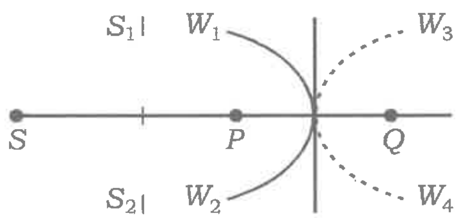
(A) 4 mm

(B) 5·6 mm

(C) 14 mm

(D) 28 mm

122. Interference fringes are being produced on screen XY by the slits S_1 and S_2. In figure, the ***correct*** fringe locus is



(A) PQ

(B) $W_1 W_2$

(C) $W_3 W_4$

(D) XY

123. The width of a single slit if the first minimum is observed at an angle 2° with a light of wavelength 6980 Å is

(A) 0·2 mm

(B) 2×10^{-5} mm

(C) 2×10^{5} mm

(D) 2 mm

124. If we observe the single slit Fraunhofer diffraction with wavelength λ and slit width e, then the width of the central maxima is 2θ. On decreasing the slit width for the same λ

(A) θ increases

(B) θ remains unchanged

(C) θ decreases

(D) θ increases or decreases depending on the intensity of light

125. A point source of electromagnetic radiation has an average power output of 800 W. The maximum value of electric field at a distance of 4·0 m from the source is

(A) 64·7 V/m

(B) 57·8 V/m

(C) 56·72 V/m

(D) 54·77 V/m

126. Two point charges $+8q$ and $-2q$ are located at $x = 0$ and $x = L$ respectively. The location of a point on the x-axis at which the net electric field due to these two point charges is zero, is

(A) $2L$

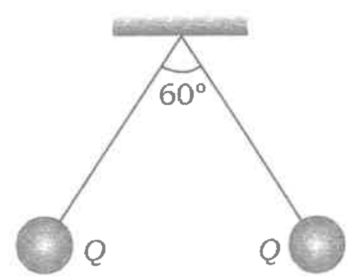
(B) $L/4$

(C) $8L$

(D) $4L$

127. Two small spherical balls each carrying a charge $Q = 10\ \mu C$ (10 micro – coulomb) are suspended by two insulating threads of equal lengths 1 m each from a point fixed in the ceiling. It is found that in equilibrium threads are separated by an angle 60° between them as shown in the figure. What is the tension in the threads?

(Given : $\frac{1}{(4\pi\varepsilon_0)} = 9 \times 10^9\ \text{Nm/C}^2$)



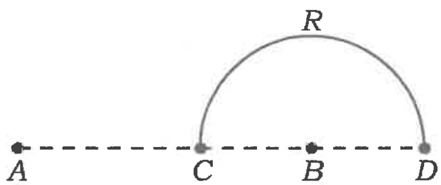
(A) 18 N

(B) 1·8 N

(C) 0·18 N

(D) None of the above

128. Charges $+q$ and $-q$ are placed at points A and B respectively which are a distance $2L$ apart. C is the midpoint between A and B. The work done in moving a charge $+Q$ along the semicircle CRD is



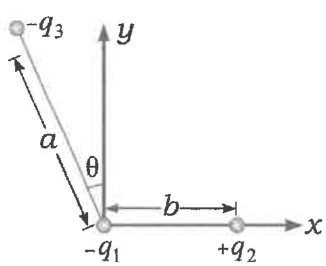
(A) $\dfrac{qQ}{4\pi\varepsilon_0 L}$

(B) $\dfrac{qQ}{2\pi\varepsilon_0 L}$

(C) $\dfrac{qQ}{6\pi\varepsilon_0 L}$

(D) $-\dfrac{qQ}{6\pi\varepsilon_0 L}$

129. Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in the figure. The x component of the force on $-q_1$ is proportional to



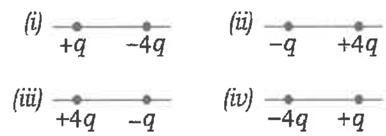
(A) $\dfrac{q_2}{b^2} - \dfrac{q_3}{a^2}\cos\theta$

(B) $\dfrac{q_2}{b^2} + \dfrac{q_3}{a^2}\sin\theta$

(C) $\dfrac{q_2}{b^2} + \dfrac{q_3}{a^2}\cos\theta$

(D) $\dfrac{q_2}{b^2} - \dfrac{q_3}{a^2}\sin\theta$

130. The figure shows four situations in which charges as indicated $(q > 0)$ are fixed on an axis. In which situation is there a point to the left of the charges where an electron would be in equilibrium?



(A) *(i)* and *(ii)*

(B) *(ii)* and *(iv)*

(C) *(iii)* and *(iv)*

(D) *(i)* and *(iii)*

131. Two unlike charges of the same magnitude Q are placed at a distance d. The intensity of the electric field at the middle point in the line joining the two charges is

(A) zero

(B) $\dfrac{8Q}{4\pi\varepsilon_0 d^2}$

(C) $\dfrac{6Q}{2\pi\varepsilon_0 d^2}$

(D) $\dfrac{4Q}{4\pi\varepsilon_0 d^2}$

132. Point charges $q_1 = 2\mu C$ and $q_2 = -1\mu C$ are kept at points $x = 0$ and $x = 6$ respectively. Electrical potential will be zero at points

(A) $x = 2$ and $x = 9$

(B) $x = 1$ and $x = 5$

(C) $x = 4$ and $x = 12$

(D) $x = -2$ and $x = 2$

133. The electric field due to an electric dipole at a distance r from its centre in axial position is E. If the dipole is rotated through an angle of 90° about its perpendicular axis, then the electric field at the same point will be

(A) E

(B) $\frac{E}{4}$

(C) $\frac{E}{2}$

(D) $2E$

134. A magnet oscillating in a horizontal plane has a time period of 2 seconds at a place where the angle of dip is 30° and 3 seconds at another place where the angle of dip is 60°. The ratio of resultant magnetic fields at the two places is

(A) $\frac{4\sqrt{3}}{7}$

(B) $\frac{4}{9\sqrt{3}}$

(C) $\frac{9}{4\sqrt{3}}$

(D) $\frac{9}{\sqrt{3}}$

135. Two short magnets having magnetic moments in the ratio 27 : 8, when placed on opposite sides of a deflection magnetometer produce no deflection. If the distance of the weaker magnet is 0·12 m from the centre of deflection magnetometer, then the distance of the stronger magnet from the centre is

(A) 0·06 m

(B) 0·08 m

(C) 0·12 m

(D) 0·18 m

136. A magnet 20 cm long with its poles concentrated at its ends is placed vertically with its north pole on the table. At a point due 20 cm south (magnetic) of the pole, a neutral point is obtained. If $H = 0{\cdot}3$ G, then the pole strength of the magnet is approximately

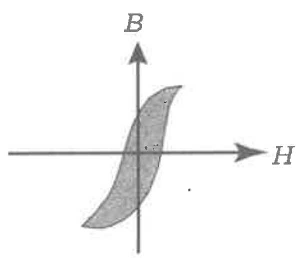
(A) 185 ab-amp-cm

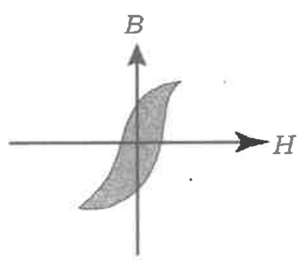
(B) 185 amp-m

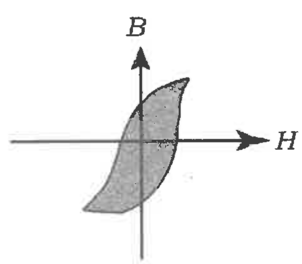
(C) 18·5 ab-amp-cm

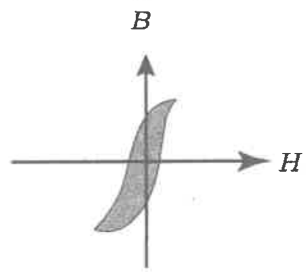
(D) 18·5 amp-cm

137. For substances hysteresis (B-H) curves are given as shown in figure. For making temporary magnet which of the following is best?

(A) 

(B) 

(C) 

(D) 

138. The effective length of a magnet is 31·4 cm and its pole strength is 0·5 Am. Calculate its magnetic moment. If it is bent in form of semicircle, then magnetic moment will be

(A) 0·157 Am^2, 0·01 Am^2

(B) 0·357 Am^2, 0·01 Am^2

(C) 1·157 Am^2, 1·01 Am^2

(D) None of the above

139. A short bar magnet of magnetic moment 255 JT^{-1} is placed with its axis perpendicular to earth's field direction. At what distance from the center of the magnet the resultant field is inclined at 45° with earth's field, $H = 0 \cdot 4 \times 10^{-4}$ T?

(A) 5 m

(B) 0·5 m

(C) 2·5 m

(D) 0·25 m

140. When a piece of a ferromagnetic substance is put in a uniform magnetic field, the flux density inside it is four times the flux density away from the piece. The magnetic permeability of the material (in N/A^2) is

(A) 1

(B) 2

(C) 3

(D) 4

141. Each atom of an iron bar (5 cm × 1 cm × 1 cm) has a magnetic moment $1 \cdot 8 \times 10^{-23}$ Am^2. Knowing that the density of iron is $7 \cdot 78 \times 10^3$ kgm^{-3}, atomic weight is 56 and Avogadro's number of $6 \cdot 02 \times 10^{23}$ the magnetic moment of bar in the state of magnetic saturation will be

(A) 4·75 Am^2

(B) 5·74 Am^2

(C) 7·54 Am^2

(D) 75·4 Am^2

142. The period of oscillations of a magnet is 2 s. When it is magnetized then the pole strength is 4 times, its period will be

(A) 4 s

(B) 1 s

(C) 2 s

(D) $\frac{1}{2}$ s

143. The needle of a deflection galvanometer shows a deflection of 60° due to a short bar magnet at a certain distance in tan A position. If the distance is doubled, then the deflection is

(A) $\sin^{-1}\left[\frac{\sqrt{3}}{8}\right]$

(B) $\cos^{-1}\left[\frac{\sqrt{3}}{8}\right]$

(C) $\tan^{-1}\left[\frac{\sqrt{3}}{8}\right]$

(D) $\cot^{-1}\left[\frac{\sqrt{3}}{8}\right]$

144. Magnets A and B are geometrically similar but the magnetic moment of A is twice that of B. If T_1 and T_2 be the time periods of the oscillation when their like poles and unlike poles are kept together respectively, then $\frac{T_1}{T_2}$ will be

(A) $\frac{1}{3}$

(B) $\frac{1}{2}$

(C) $\frac{1}{\sqrt{3}}$

(D) $\sqrt{3}$

145. Instantaneous displacement current of 1·0 A in the space between the parallel plate of 1 μF capacitor can be established by changing potential difference of

(A) $10^{-6}\,\text{Vs}^{-1}$

(B) $10^{6}\,\text{Vs}^{-1}$

(C) $1\,\text{Vs}^{-1}$

(D) $0{\cdot}1\,\text{Vs}^{-1}$

146. The magnetic field between the plate of a capacitor when $r < R$ is given by

(A) $\frac{\mu_0 i_D r}{2\pi R^2}$

(B) $\frac{\mu_0 i_D}{2\pi R}$

(C) $\frac{\mu_0 i_D}{2\pi r}$

(D) zero

147. A cube of edge a has its edges parallel to x, y and z-axis of rectangular coordinate system. A uniform electric field $\vec{E}$ is parallel to y-axis and a uniform magnetic field is $\vec{E}$ parallel to x-axis. The rate at which flows through each face of the cube is

(A) $\frac{a^2EB}{2\mu_0}$ parallel to $x-y$ plane and zero in others

(B) $\frac{a^2EB}{\mu_0}$ parallel to $x-y$ plane and zero in others

(C) $\frac{a^2EB}{2\mu_0}$ from all faces

(D) $\frac{a^2EB}{2\mu_0}$ parallel to $y-z$ faces and zero in others

148. A particle of mass 1×10^{-26} kg and charge $1{\cdot}6 \times 10^{-19}$C travelling with a velocity $1{\cdot}28 \times 10^{6}\,\text{ms}^{-1}$ along the positive X-axis enters a region in which a uniform electric field E and a uniform magnetic field of induction B are present. If $E = -10{\cdot}24 \times 10^3\,\hat{k}\,\text{NC}^{-1}$ and $B = 8 \times 10^{-2}\,\hat{j}\,\text{Wbm}^{-2}$, then the direction of motion of the particles is

(A) along the positive X-axis

(B) along the negative X-axis

(C) at 45° to the positive X-axis

(D) at 135° to the positive X-axis

149. A radiation of energy E falls normally on a perfectly reflecting surface. The momentum transferred to the surface is

(A) $\frac{E}{c}$

(B) $\frac{2E}{c}$

(C) Ec

(D) $\frac{E}{c^2}$

150. A TV tower has a height of 100 m. How much population is covered by the TV broadcast if the average population density around the tower is $100\ \text{km}^{-2}$ (radius of the earth = $6\cdot37 \times 10^6$ m)?

(A) 4 lakh

(B) 4 billion

(C) 40,000

(D) 40 lakh

151. A gas at pressure p is adiabatically compressed so that its density becomes twice that of initial value. Given that $\gamma = C_p/C_v = 7/5$, what will be the final pressure of the gas?

(A) $2\,p$

(B) $\frac{7}{5}p$

(C) $2\cdot63\,p$

(D) p

152. Ten moles of an ideal gas at constant temperature 500 K is compressed from 50 L to 5 L. Work done in the process is (Given, $R = 8\cdot31\ \text{J} - \text{mol}^{-1} - \text{K}^{-1}$)

(A) $-1\cdot2 \times 10^4$ J

(B) $-2\cdot4 \times 10^4$ J

(C) $-4\cdot8 \times 10^4$ J

(D) $-9\cdot6 \times 10^4$ J

153. At constant temperature, the volume of a gas is to be decreased by 4%. The pressure must be increased by

(A) 4%

(B) 4·16%

(C) 8%

(D) 3·86%

154. A gas is suddenly compressed to ¼th of its original volume at normal temperature. The increase in its temperature is, $\gamma = 1\cdot5$.

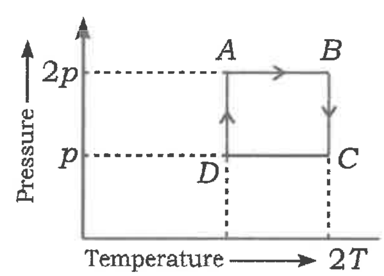
(A) 273 K

(B) 573 K

(C) 373 K

(D) 473 K

155. One mole of an ideal gas having initial volume V, pressure $2p$ and temperature T undergoes a cyclic process $ABCDA$ as shown below :



The net work done in the complete cycle is

(A) zero

(B) $\frac{1}{2}RT\ \ln 2$

(C) $RT \ln 2$

(D) $\frac{3}{2}RT\ \ln 2$

156. A Carnot engine used first ideal monoatomic gas and then an ideal diatomic gas. If the source and sink temperatures are 411 °C and 69 °C respectively and the engine extract 1000 J of heat from the source in each cycle, then

(A) area enclosed by the $p-V$ diagram is 10 J

(B) heat energy rejected by engine in 1st case is 600 J while that in 2nd case is 113 J

(C) area enclosed by the $p-V$ diagram is 500 J

(D) efficiencies of the engine in both the cases are in ratio 21 : 25

157. A Carnot reversible engine converts 1/6 of heat input into work. When the temperature of the sink is reduced by 62 K, the efficiency of Carnot's cycle becomes 1/3. The temperature of the source and sink will be

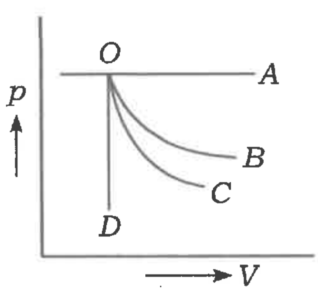
(A) 372 K, 310 K

(B) 181 K, 150 K

(C) 472 K, 410 K

(D) None of the above

158. A graph of pressure versus volume for an ideal gas for different processes is as shown. In the graph, curve OC represents



(A) isochoric process

(B) isothermal process

(C) isobaric process

(D) adiabatic process

159. For an adiabatic expansion of a perfect monoatomic gas, when volume increases by 24%, what is the percentage decrease in pressure?

(A) 24%

(B) 30%

(C) 48%

(D) 71%

160. Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways. The work done by the gas is W_1 if the process is purely isothermal, W_2 if purely isobaric and W_3 if purely adiabatic. Then

(A) $W_2 > W_1 > W_3$

(B) $W_2 > W_3 > W_1$

(C) $W_1 > W_2 > W_3$

(D) $W_1 > W_3 > W_2$

161. When a piece of metal is illuminated by a monochromatic light of wavelength λ, then stopping potential is $3\ V_s$. When same surface is illuminated by light of wavelength 2λ, then stopping potential becomes V_s. The value of threshold wavelength for photoelectric emission will be

(A) 4λ

(B) 8λ

(C) $\frac{4}{3}\lambda$

(D) 6λ

162. In photoelectric effect if the intensity of light is doubled, then maximum kinetic energy of photoelectrons will become

(A) double

(B) half

(C) four times

(D) no change

163. In a photo-emissive cell with exciting wavelength λ, the fastest electron has speed v. If the exciting wavelength is changed to $3\lambda/4$, then the speed of the fastest emitted electron will be

(A) $v\left(\frac{3}{4}\right)^{1/2}$

(B) $v\left(\frac{4}{3}\right)^{1/2}$

(C) less than $v\left(\frac{4}{3}\right)^{1/2}$

(D) greater than $v\left(\frac{4}{3}\right)^{1/2}$

164. If a voltage applied to an X-ray tube is increased to 1·5 times the minimum wavelength (λ_{min}) of an X-ray continuous spectrum shifts by $\Delta\lambda = 26$ pm. The initial voltage applied to the tube is

(A) ≈ 10 kV

(B) ≈ 16 kV

(C) ≈ 50 kV

(D) ≈ 75 kV

165. If m is the mass of an electron and c is the speed of light, then the ratio of the wavelength of a photon of energy E to that of the electron of the same energy is

(A) $c\sqrt{\frac{2m}{E}}$

(B) $\sqrt{\frac{2m}{E}}$

(C) $\sqrt{\frac{2m}{cE}}$

(D) $\sqrt{\frac{m}{E}}$

166. A photon of $1{\cdot}7 \times 10^{-13}$ Joules is absorbed by a material under special circumference. The ***correct*** statement is

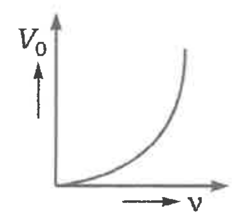
(A) electrons of the atom of absorbed material will go to the higher energy states

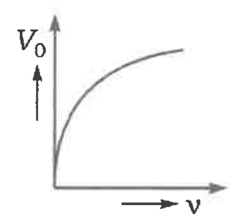
(B) electron and positron pair will be created

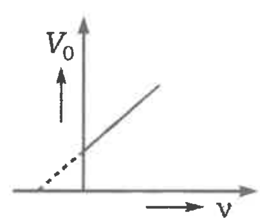
(C) only positron will be produced

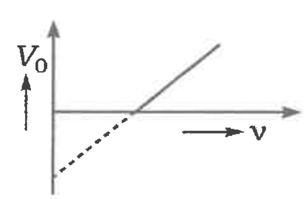
(D) photoelectric effect will occur and electron will be produced

167. For a photoelectric cell, the graph showing the variation of cut-off voltage (V_0) with frequency (ν) of incident light is best represented by

(A)


(B)


(C)


(D)


168. A particle of charge -16×10^{-18} C moving with velocity 10 ms^{-1} along the x-axis enters a region where a magnetic field of induction B is along the y-axis and an electric field of magnitude 10^4 Vm^{-1} is along the negative z-axis. If the charged particle continues moving along the x-axis, the magnitude of B is

(A) 10^3 Wbm^{-2}

(B) 10^5 Wbm^{-2}

(C) 10^{16} Wbm^{-2}

(D) 10^{-3} Wbm^{-2}

169. An important spectral emission line has a wavelength of 21 cm. The corresponding photon energy is ($h = 6{\cdot}62 \times 10^{-34}$ Js and $c = 3 \times 10^8 \text{ ms}^{-1}$)

(A) $5{\cdot}9 \times 10^{-8}$ eV

(B) $5{\cdot}9 \times 10^{-4}$ eV

(C) $5{\cdot}9 \times 10^{-6}$ eV

(D) $11{\cdot}8 \times 10^{-6}$ eV

170. A charge of magnitude $3e$ and mass $2m$ is moving in an electric field E. The acceleration imparted to the charge is

(A) $2Ee/3m$

(B) $3Ee/2m$

(C) $2m/3Ee$

(D) $3m/2Ee$

171. Wavelength of first line in Lyman series is λ. The wavelength of first line in Balmer series is

(A) $\frac{5}{27}\lambda$

(B) $\frac{36}{5}\lambda$

(C) $\frac{27}{5}\lambda$

(D) $\frac{5}{36}\lambda$

172. The first excited state of hydrogen atoms is $10{\cdot}2$ eV above its ground state. The temperature needed to excite hydrogen atoms to first excited level is

(A) $7{\cdot}9 \times 10^4$ K

(B) $3{\cdot}5 \times 10^4$ K

(C) $5{\cdot}8 \times 10^4$ K

(D) 14×10^4 K

173. If λ is the wavelength of hydrogen atom from the transition $n = 3$ to $n = 1$, then what is the wavelength for doubly ionised lithium ion for the same transition?

(A) $\frac{\lambda}{3}$

(B) 3λ

(C) $\frac{\lambda}{9}$

(D) 9λ

174. In H spectrum, the wavelength of H_α line is 656 nm whereas in a distance galaxy, the wavelength of H_α line is 706 nm. Estimate the speed of galaxy with respect to earth.

(A) $2 \times 10^8 \text{ ms}^{-1}$

(B) $2 \times 10^7 \text{ ms}^{-1}$

(C) $2 \times 10^6 \text{ ms}^{-1}$

(D) $2 \times 10^5 \text{ ms}^{-1}$

175. The first member of the Balmer's series of the hydrogen has a wavelength λ. The wavelength of the second member of its series is

(A) $\frac{27}{20}\lambda$

(B) $\frac{20}{27}\lambda$

(C) $\frac{25}{20}\lambda$

(D) None of the above

176. The ionisation potential of mercury is 10·39 V. How far an electron must travel in an electric field of $1{\cdot}5 \times 10^6 \text{ Vm}^{-1}$ to gain sufficient energy to ionize mercury?

(A) $\frac{10{\cdot}39}{1{\cdot}5 \times 10^6} \times 1{\cdot}0 \times 10^{-19}$ m

(B) $\frac{10{\cdot}39}{1{\cdot}5 \times 10^6}$ m

(C) $1{\cdot}39 \times 1{\cdot}6 \times 10^{-19}$ m

(D) $\frac{10{\cdot}39}{1{\cdot}6 \times 10^{-19}}$ m

177. The magnetic moment of the ground state of an atom whose open sub-shell is half-filled with five electrons is

(A) $\sqrt{35}\sqrt{\mu_B}$

(B) $35\,\mu_B$

(C) $35\sqrt{\mu_B}$

(D) $\mu_B\sqrt{35}$

178. A sample contains 16 g of a radioactive material, the half-life of which is two days. After 32 days, the amount of radioactive material left in the sample is

(A) less than 1 mg

(B) $\frac{1}{4}$ g

(C) $\frac{1}{2}$ g

(D) 1 g

179. If $N_1 = N_0 e^{-\lambda t_1}$, then the number of atoms decayed during time interval from t_1 to $t_2 (t_2 > t_1)$ will be

(A) $N_{t_1} = N_{t_2} = N_0[e^{-\lambda t_1} - e^{-\lambda t_2}]$

(B) $N_{t_2} = N_{t_1} = N_0[e^{-\lambda t_2} - e^{-\lambda t_1}]$

(C) $N_{t_2} - N_{t_1} = N_0[e^{\lambda t_2} - e^{-\lambda t_1}]$

(D) None of the above

180. The energy equivalent to 1 mg of matter in MeV is

(A) $56 \cdot 25 \times 10^{22}$

(B) $56 \cdot 25 \times 10^{24}$

(C) $56 \cdot 25 \times 10^{26}$

(D) $56 \cdot 25 \times 10^{28}$

181. The mass defect in particular nuclear reaction is 0·3 g. The amount of energy liberated in kilowatt hour is (velocity of light = 3×10^8 ms^{-1})

(A) $1 \cdot 5 \times 10^6$

(B) $2 \cdot 5 \times 10^6$

(C) 3×10^6

(D) $7 \cdot 5 \times 10^6$

182. The number of α-particles and β-particles respectively emitted in the reaction ${}_{88}A^{196} \rightarrow {}_{78}B^{164}$ are

(A) 8 and 8

(B) 8 and 6

(C) 6 and 8

(D) 6 and 6

183. The half-life period of a radioactive substance is 3 days. Three fourth of a substance decays in

(A) 3 days

(B) 6 days

(C) 9 days

(D) 12 days

184. If one starts with one curie of radioactive substance ($T_{1/2} = 12$ hrs), then the activity left after a period of 1 week will be about

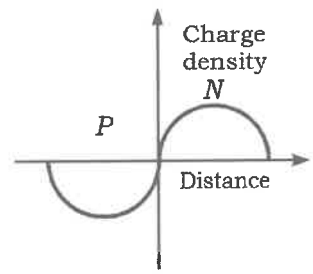
(A) 1 curie

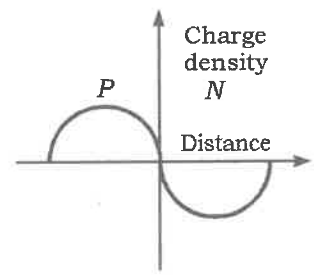
(B) 120 microcurie

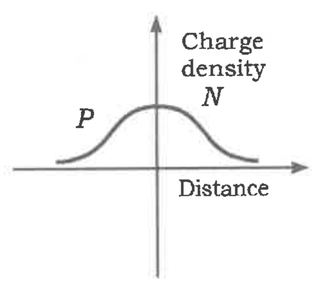
(C) 60 microcurie

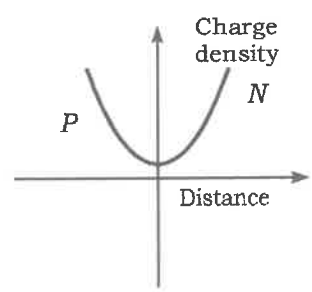
(D) 8 millicurie

185. The curve between charge density and distance near P-N junction will be

(A)


(B)


(C)


(D)


186. The voltage gain of an amplifier with 9% negative feedback is 10. The voltage gain without feedback will be

(A) 1·25

(B) 100

(C) 90

(D) 10

187. The binary number 10111 is equivalent to the decimal number

(A) 19

(B) 31

(C) 23

(D) 22

188. In space charge limited region, the plate current in a diode is 10 mA for plate voltage 150 V. If the plate voltage is increased to 600 V, then the plate current will be

(A) 10 mA

(B) 40 mA

(C) 80 mA

(D) 160 mA

189. On applying a potential of −1 volt at the grid of a triode, the following relation between plate voltage V_p (volt) and plate current I_p (in mA) is found $I_p = 0{\cdot}125\,V_p - 7{\cdot}5$. If on applying −3 volt potential at grid and 300 V potential at plate, the plate current is found to be 5 mA, then amplification factor of the triode is

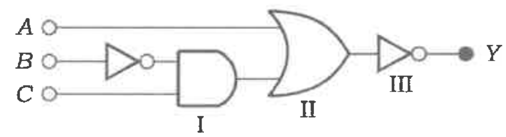
(A) 100

(B) 50

(C) 30

(D) 20

190. The output Y of the logic circuit shown in the figure is best represented as



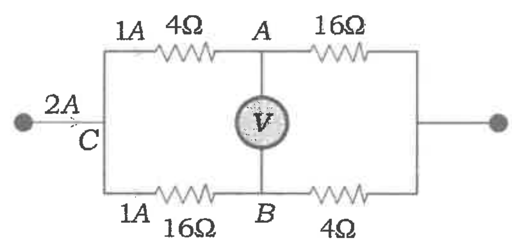
(A) $\overline{A} + \overline{B \cdot C}$

(B) $A + \overline{B} \cdot C$

(C) $\overline{A + B \cdot C}$

(D) $\overline{A + \overline{B} \cdot C}$

191. In the circuit shown below, the reading of the voltmeter V is



(A) 12 V

(B) 8 V

(C) 20 V

(D) 16 V

192. In a meter bridge, a 30 Ω resistance is connected in the left gap and a pair of resistances P and Q in the right gap. Measured from the left, the balance point is 37·5 cm when P and Q are in series and 71·4 cm when they are parallel. The values of P and Q (in ohm) are

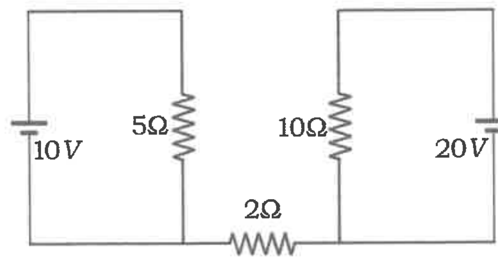
(A) 40, 10

(B) 35, 15

(C) 30, 20

(D) 25, 25

193. Find out the value of current through $2\,\Omega$ resistance for the given circuit.



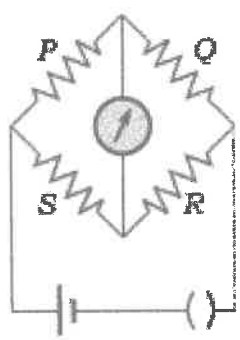
(A) 5 A

(B) 2 A

(C) Zero

(D) 4 A

194. In the Wheatstone's bridge shown, $P = 2\,\Omega$, $Q = 3\,\Omega$, $R = 6\,\Omega$ and $S = 8\,\Omega$. In order to obtain balance, shunt resistance across S must be



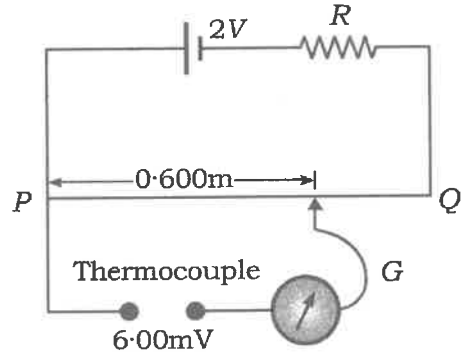
(A) $2\,\Omega$

(B) $3\,\Omega$

(C) $6\,\Omega$

(D) $8\,\Omega$

195. The given figure shows a simple potentiometer circuit for measuring a small e.m.f. produced by a thermocouple. The meter wire PQ has a resistance $5\,\Omega$ and the driver cell has an e.m.f. of 2 V. If a balance point is obtained 0·600 m along PQ when measuring an e.m.f. of 6·00 mV, what is the value of resistance R?



(A) $995\,\Omega$

(B) $1995\,\Omega$

(C) $2995\,\Omega$

(D) None of the above

196. An AC source of angular frequency ω is fed across a resistor r and a capacitor C in series. The current registered is I. If the frequency of source is changed to $\omega/3$ (maintaining the same voltage), then the current in the circuit is found to be halved. Calculate the ratio of reactance to resistance at the original frequency ω.

(A) $\sqrt{\frac{3}{5}}$

(B) $\sqrt{\frac{2}{5}}$

(C) $\sqrt{\frac{1}{5}}$

(D) $\sqrt{\frac{4}{5}}$

197. When a DC voltage of 200 V is applied to a coil of self-inductance $\left(\frac{2\sqrt{3}}{\pi}\right)$H, a current of 1 A flows through it. But by replacing DC source with AC source of 200 V, the current in the coil is reduced to 0·5 A. Then the frequency of AC supply is

(A) 100 Hz

(B) 75 Hz

(C) 60 Hz

(D) 50 Hz

198. A virtual current of 4 A and 50 Hz flows in an AC circuit containing a coil. The power consumed in the coil is 240 W. If the virtual voltage across the coil is 100 V its inductance will be

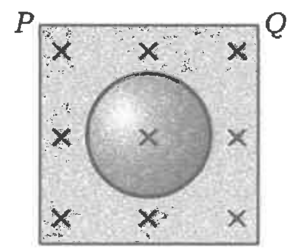
(A) $\frac{1}{3\pi}$ H

(B) $\frac{1}{5\pi}$ H

(C) $\frac{1}{7\pi}$ H

(D) $\frac{1}{9\pi}$ H

199. A vertical ring of radius r and resistance R falls vertically. It is in contact with two vertical rails which are joined at the top in the given figure. The rails are without friction and resistance. There is a horizontal uniform magnetic field of magnitude B perpendicular to the plane of the ring and the rails. When the speed of the ring is v, then the current in the section PQ is



(A) zero

(B) $\frac{2Brv}{R}$

(C) $\frac{4Brv}{R}$

(D) $\frac{8Brv}{R}$

200. In an electrical circuit R-L-C and an AC voltage source are all connected in series. When L is removed from the circuit, the phase difference between the voltage and the current in the circuit is $\pi/3$. If instead, C is removed from the circuit, the phase difference is again $\pi/3$. The power factor of the circuit is

(A) $1/2$

(B) $1/\sqrt{2}$

(C) 1

(D) $\sqrt{3}/2$

SPACE FOR ROUGH WORK

SPACE FOR ROUGH WORK

SPACE FOR ROUGH WORK

SEAL

★ ★ ★